and with much interest, with reference to its capability to withstand *heavy* or "*common use*," and the conclusion has been arrived at, that it may be tried for such latter use with a strong probability of success.

Loaded wagons employed on the Park have frequently been driven over the road, without producing any sensible disturbance or injurious effect upon the surface, and, from all indications that are presented, it will bear the heaviest traffic equally well with the MacAdam and the Telford roads.

Superior economy and facility of construction, and a superior surface over the latter roads, are strong incentives to a thorough and conclusive experiment upon this point.

(To be continued.)

From the London Engineering, August, 1867.

BESSEMER STEEL BOILER PLATES.

We have before us a large photograph of one of the steel boilers to which we referred May 17th last, (vol. iii., page 515,) as giving way under a hydraulic test. This was some years ago, before proper attention had been given to the testing and selection of steel. One of the longitudinal seams gave way, the steel cracking between the rivet holes. The next plate broke clean across through the solid, almost as short as glass; another cracked nearly across diagonally, and another for about 3 feet circumferentially. The failure was most complete, and the makers of the boilers, who had made them to specification, and without taking any responsibility for the quality of the steel, lost no time in sending out a private circular to their friends warning them against steel boilers generally.

Hundreds of large steel boilers have, however, been since made and tested, and are now under steam, giving every satisfaction. And when we say steel, we mean Bessemer steel, which is now sold at the price of Lowmoor iron. We published the tests of Messrs. Charles Cammell & Co.'s plates, of both Bessemer and crucible steel, on page 519 of our last volume. The forge test (hot) for all Bessemer plates 1 inch thick and under, is to bend 180°, either with or across the grain, without cracking. Tested cold, the ½ inch plates are to bend 80° with the grain and 60° across the grain. The tensile strength of the steel to stand this test is 33 tons per square inch, or about one-half more than that of Lowmoor iron. If the steel be made much stronger, it is correspondingly harder, and is apt to be brittle, whereas the 33-ton steel has none of the brittleness ordinarily associated with our ideas of steel.

Among the various makers of Bessemer steel plates, the Bolton

Steel and Iron Company have gained a good name for the strength and toughness of their work. We saw at Bolton, this week, great numbers of tested samples, all of which had been bent much beyond the Admiralty requirement, without the least sign of cracking. From every plate made the edges are sheared and tested, and cracking is hardly ever known. We saw a long shearing from a $\frac{1}{2}$ inch plate, the width of the shearing being but $\frac{1}{8}$ inch, the plate having been first sheared $\frac{1}{8}$ inch too long. This was a surprising test, for the steel was as sound as if it had been planed to the same thickness.

It is admitted that the punch induces brittleness in steel plates, and it would be better were the drill used for all rivet holes. The full strength of the steel is restored, however, after punching, by annealing, and at the works of Messrs. Hick, Hargreaves & Co., of Bolton, who make many steel boilers, every plate is annealed along the edges after punching. Steel is used not only for the shell of the boiler, but for the flues as well, and, indeed, many steel flues are made for iron boilers. As at Messrs. Cammell & Co.'s works, so at those of the Bolton Iron and Steel Company, nearly all the boilers are of steel made on the premises. Mr. Webb, of the Bolton Company, and who is so well known as having been for a long time the principal assistant of Mr. Ramsbottom, at Crewe, has all his boilers double riveted on all seams, the diameter and pitch of the rivets being somewhat less than for iron, the plates being correspondingly thinner. Besides the tests of the plates, all steel boilers are tested when made, and their superiority in strength over iron is such that, in all first-class work, it is certain that steel boilers must become the rule and iron the exception. Steel has a further advantage, also, over iron, in being less liable to corrosion, a source of danger furnishing about forty cases every month to the inspectors of the Manchester Boiler Association, and which is the cause of a large proportion of the annual number of boiler explosions.

THE EAST RIVER BRIDGE.

ENGINEER'S REPORT.

THE following Report of the engineer, John A. Roebling, showing the location, the plan, the anchorage and approaches of the East River Bridge, was read at a meeting of the New York Bridge Company on Saturday night, September 7th.

The Report is dated Trenton, N. J., September 1st, 1867, and commences by stating that the object of the Report is to establish the practicability of bridging the East River without interfering with the navigation; to point out the best locality; to explain the different parts of its construction, and to estimate its probable cost and revenue. By the charter of the Company the Brooklyn terminus of the

bridge is confined to a point at or near the junction of Main and Fulton Streets; for the New York terminus a latitude is allowed ranging from Chatham Square along Chatham Street to the junction of Nassau and Chatham. Through this legislative provision the surveys have been confined to two lines or routes, one terminating at Chatham Square, the other opposite the City Hall Park. By way of comparison, another route is added in the following table:

	Park line. Feet.	Chatham Square. Feet.	Bowery and Canal. Feet.
Distance across river from pier line to pier line	1512	1302	1345
River span from centre to centre tower	1600	1430	1443
Length of New York approach from the terminus to centre of tower	2361	1916	2771
Length of approach on Brooklyn side	1881	1804	1780
Total length	5862	5200	5984
Elevation of New York terminus above high tide	36	32	49
Elevation of Brooklyn terminus above high tide	68	68	63

The Park line recommends itself as the true line of the bridge, on account of the location of its New York terminus, opposite the Registrar's office in the Park. This point will collect and accommodate more travel than Chatham Square. Although the length of this line exceeds the Chatham Square line, and its central span will also be 120 feet greater, yet its more favorable location will far outweigh these and much weightier considerations. For the next fifty years to come, the City Hall Park will remain the great focus of travel, from which speedy communications will ramify in all directions. Its easier grade is an important point in its favor. It also so happens that much less valuable property will be occupied on this line than on any other. Indeed, it is a curious circumstance that on the Park line, in a distance of 1200 feet from the terminus of the anchorage, only three valuable buildings will have to be appraised, and these are near Franklin Square. Should the building of the bridge go hand in hand, as is proposed, with the improvements of the ground underneath, then, indeed, this work will greatly beautify and improve this part of the city, which appears to need it more than any other. To improve the entrance to the bridge, it may be found necessary to occupy the offices of *The Daily News* and of the *Staats Zeitung*,

which will increase the number of valuable buildings from three to five. The clear elevation of the river span in the centre is fixed by the charter at no less than 130 feet, high tide. I propose to consume only six feet below the floor of the bridge for trussing, in order to make the grade as easy as possible. This enables me to keep the ascent on the Park line down to 3·44 feet per 100. On the Chatham Square line the ascent would be 4·23 in 100, and this increase is a strong argument against this route. The difference in cost of the two lines is in favor of the Chatham Square route, but this difference amounts to less than one-half million of dollars, estimating property and all. I have come to the conclusion that, when in the comparison of the two lines the future revenues of the two bridges are taken into account, the greater value of the Park line will be rendered so conspicuous that its selection can be subject to no doubt. I have therefore confined my detail labors to the Park line, as the true route which will most favor the interests of the community, as well as of the Bridge Company. The Park line commences opposite the Registrar's office on Chatham Street, then crosses North William, William, Rose, Vandewater, Cliff, Franklin Square, Cherry, Water, Front and South; thence to the end of the old Pier No. 29, now broken down; the line continues in a straight course across the river, and then passes on the Brooklyn shore nearly through the centre of the spare slip of the Fulton Ferry Company; thence passing over Water, Dock and Front. A part of James Street, near Garrison, will be occupied by the Brooklyn anchorage. Leaving the anchorage, the line continues to pass over James, and then crossing York and Main Streets, obliquely, deflects toward Fulton; after crossing Prospect, near its intersection with Fulton, it terminates finally in the block which is bounded by Fulton, Prospect, Sands and Washington. The exact location of this terminus should not be determined before final surveys have been made and the line has been actually traced on the ground. Between the two termini the whole length of the bridge was stated at 5862 feet, though this may vary after the Brooklyn terminus shall have been finally located. Of this whole length, 3480 feet will be suspended in three openings. The central span will cross the river from pier line to pier line, without impeding the navigation, in one single span of exactly 1600 feet from centre to centre of tower. From each tower toward the land side half-spans will be supported by the land cables, 940 feet long each, measuring from the centre of the tower to the face of the anchor wall. From the anchor

wall, on the New York side, a distance remains of 1337 feet to Chatham Street, opposite the Registrar's office. The distance from the anchor wall to the Brooklyn terminus measures 837 feet. The greater length of the bridge, therefore, forms a suspension bridge proper. For a better understanding of the subject, those portions between the anchor walls and the termini I shall call approaches. These approaches will be supported by iron girders and trusses, and these will rest at short intervals upon small piers of masonry or iron columns, located within those blocks of buildings which will be crossed and occupied. These pillars will form parts of walls needed for the division of the occupied ground into stores, dwellings or offices. In every such case the bridge-floor will be constructed perfectly fire and water-proof, so as to serve as a roof for the blocks of houses and stores underneath. The streets will be crossed by iron girders at such elevations as to leave them unobstructed. This can be accomplished even in the crossing of North William Street in New York, so that on this side no necessity will arise for the vacation of any one street. In the crossing of Franklin Square, both girders and trusses will be employed. From the anchorage toward the river the bridge-floor is suspended to the cables, and therefore needs no support. The elevation will be so high that the roofs of the buildings underneath will be cleared. This elevation at the anchorage will be 85 feet 8 inches above high tide, ascending toward the river at the rate of 3 feet 5 inches in each 100 feet. The iron framing which forms the bridge-floor is 80 feet wide. The width is divided in five spaces, marked by six lines of iron trusses. The two outside spaces are 15 feet wide in the clear between the chords, and 15 feet 5 inches between the posts, and form roadways for all kinds of common travel. Iron tramways are laid down, 13 inches wide, for the wheels to run on the same arrangement as on the Cincinnati bridge, leaving a width of 4 feet 8½ inches in the clear for horses to walk on. The remaining 6 feet serve as a sidewalk for pedestrians. All vehicles and passengers who go by the roadway will take the right-hand track, which arrangement will prevent crowding and confusion. The next two spaces are 13 feet wide each, and are to be provided with steel rails for the running of two passenger trains of cars, back and forward, alternately. These trains will be attached to an endless wire rope, which is to be propelled by a stationary engine, located on the Brooklyn side, underneath the floor. These two tracks, therefore, will be treated exactly like an inclined plane, an operation perfectly simple and perfectly

well understood. I propose an effective running speed of twenty miles per hour as perhaps the one most likely preferred. But this speed in the centre of the bridge may be increased to thirty and even forty miles per hour, with entire and absolute safety. In well-built cars, moving on a straight line, and over a perfect track, this motion will be scarcely felt. The starting and stopping will be gradual, and will be under the control of the engineer. Allowing for the discharge of a train one minute, and for its filling another minute, including the time in stopping and starting the train, there remain three minutes to run over one mile of the bridge. A speed of twenty miles is sometimes maintained on some of the heaviest coal inclines in our coal regions, rising one in ten and with loads of several hundred tons of coal in one single train, propelled by the wire ropes of 2½ inches diameter. The number of cars may be increased to ten in each train, each car 50 feet long from coupling, and 11½ feet outside, with a capacity to seat one hundred persons comfortably. Each car is to be divided crossways into eight coupes or sections. Each section will have two seats, fronting each other, and each seat will admit six to eight persons. I allow in this estimate twelve to thirteen persons for each section, or about one hundred persons for one car. Each section has two opposite doors, one for coming in, the other for going out. These doors are to be suspended sliding doors, and connected with each other by light bars, so that the eight doors on each side of a car can be opened or closed at one operation by the conductors. Two conductors will go with each train and attend to the opening and closing of these doors. The different cars being all attached to the same wire rope, their relative position will be fixed, and the rows of doors on each train may be opened and closed by a small windlass on the platform at each end. Each car will be supplied with such a windlass, so that the number of cars may be either increased or diminished. Or the closing and opening may be made self-acting, as the trains leave or enter the depot. Each car has opposite doors; those which point forward to the centre of the line are for entering, the opposite ones serve for going out. On the arrival of a train, the inside passengers step out through the *outside* doors upon an independent sidewalk of 10 feet wide, which leads out of the depot, either to the right or the left of the central walk, without interfering with the incoming passengers. For this reason the whole width of the bridge is widened out to 100 feet for a length of 500 feet at each terminus. Outside of these sidewalks are the common roadways

securely fenced off. It is proposed to build the cars substantial but light, entirely of iron and steel. Another system of running cars suggests itself, which may be termed the *circulating* system. In place of a reciprocating motion of the two trains, the wire rope is kept running around in one direction only, and each car, singly, as it fills with passengers, is to be attached to the rope and started. On its arrival at the opposite end, this car is detached and run over to the other track, and in its turn conveys a load back again. Thus the cars will be kept moving singly, in a circular route, always crossing at the ends, from one track to another. At first sight, this system seems to recommend itself as the best of the two. But there will be some practical difficulties to overcome, which can only be done experimentally on a large scale. I think I can make this system work successfully, but at present I prefer the other as one perfectly established and involving no new and untried features. The wire ropes are supported on small rollers every 15 feet. They are to be driven by steam-engines located on the Brooklyn side. These engines will be double, cranks set at right angles. Duplicate sets of engines and boilers will be provided, so that one set may always be kept in order, ready for action should anything occur to the other. There will also be a spare wire rope ready, laid down upon the tracks, so that the old one may be replaced at any time of night, should it become necessary. Suppose there was an invasion by a foreign enemy, landing on the Long Island shore, and it became necessary to transport large masses of soldiers and trains of artillery from New York to Brooklyn in as short a period of time as possible. In such an emergency the bridge would be taken possession of by the military authorities, until all the troops had been passed. Running full trains day and night, say one train every five minutes, twelve trains with one thousand men each will be passed over to Brooklyn every hour, or two hundred and eighty-eight thousand men in twenty-four hours in one direction. Adding the men who can pass on foot over the central walk and over the roadways, together with the artillery and baggage trains, the total number that may be passed without crowding would reach nearly half a million. The number of persons now carried annually by the boats of all the ferries of the Union Ferry Company is stated officially at forty million; this would be one hundred and nine thousand five hundred and eighty-nine persons per day uniformly distributed over three hundred and sixty-five days. It is plain that this number of people can be passed over the bridge alone with ease and comfort.

But should great irregularity be the rule at times, it is certain that forty million of passengers can be conveyed over the railroad tracks annually without confusion and without crowding. The central or fifth division of the bridge-floor remains to be spoken of. This elevated promenade will allow people of leisure and old and young invalids to promenade over the bridge on fine days, in order to enjoy the beautiful views and fine air. I need not state that in a crowded commercial city such a promenade will be of incalculable value. Every stranger who visits the city will, at least, take one or two walks on this promenade, and the receipts of the Bridge Company from this source alone will be quite large. At each terminus, where the bridge-floor is widened out to 100 feet, the central walk is 15 feet wide, and its floor is on a level with the floors of the railway cars. Beyond this, where the anchorage is reached, its level will be raised to the top chords of the central trusses, as represented in the cross-section of the suspended structure. At each tower the promenade further ascends six feet, by means of flights of steps, and is divided into two walks, which pass *around* the central piers high enough to allow the railway cars to pass under it. The cables of the East River Bridge will have a deflection of 128 feet, which is 1–12·5 of the span. The best quality of iron wire, if suspended over a chasm of about 6000 feet, and with a deflection of 1–12·5, or 480 feet, will only be exposed to one-third of its breaking strain. Reducing the width of the chasm to 3000 feet, the tension will only be one-sixth of the breaking strain. It is plain, therefore, that the central span of the East River Bridge, which is only 1600 feet from centre to centre of tower, is far within the limits of good wire. A span of 1600 feet or more can be made just as safe, and as strong in proportion, as a span of 100 feet. The larger span is not a question of practicability, but simply a question of cost. But as the span increases so does the cost increase. The weight of superstructure of the East River span, as far as supported by the cable and stays, and including the weight of four steel cables, is equal to 3483 tons. The maximum transitory weight which can at any one time come on the bridge by crowds of people on the road and footways, and the railway trains fully loaded, will be 1270 tons, making an aggregate of 4753 tons. In this calculation the maximum weight on the road and footways is assumed at 30 pounds per superficial foot, which is the actual weight of a dense crowd of people moving freely and promiscuously. More weight can be placed upon the floor, but not without *packing*. It is further assumed that

the superstructure is suspended to four cables of 11 inches diameter each, made of the best quality of steel wire, and which are assisted by 280 stays, each stay of an ultimate strength of 100 tons net. The aggregate strength of the cable stays will be equal to six times the tension that will result from the above maximum weight. The question whether iron wire or steel wire should be used in the cables need not be decided now. If iron wire is employed, the cables will have to be nearly 35 inches in diameter, in place of 11 inches of steel. To guard against vertical and horizontal oscillations, and to insure that degree of stiffness in the flooring which is absolutely necessary to meet the effect of violent gales in such an exposed situation, I have provided six lines of iron trusses, which run the whole length of the suspended floor from anchor wall to anchor wall. The iron floor beams, which are spaced in pairs, 7 feet 6 inches apart, intersect the longitudinal trusses at right-angles, and are riveted to the middle chords and to the upright posts. The height of each truss is 12 feet, the floor being laid above the centre, so that the upper part of the truss-frame answers for protection, as well as division, in place of railings. Those parts of the longitudinal trusses which extend below the floor-beams afford an excellent means for *lateral* trussing and bracing. A most effective framing is thus obtained, which will be found to possess ample stiffness even in the greatest emergency. I am not disposed to underrate the great force of a severe gale, when directed toward the suspended work, and I am also fully aware that herein lies the great danger to all suspension bridges of ordinary design. But my system of construction differs radically from that formerly practiced, and I have planned the East River Bridge with a special view to fully meet these destructive forces. It is for the same reason that, in my calculation of the requisite supporting strength, so large a proportion has been assigned to stays in place of cables. The East River Bridge will form a huge truss of 1600 feet span, and of a depth of 150 feet. The towers form one supporting element, the framing of the floor forms the second, and the extensive system of stays forms the third. The stays are arranged in four distinct planes connected by the floor. The latter, in connection with the stays, will support itself without the assistance of the cables. If the structure is viewed in this light it will make a different impression upon those who are in the habit of associating with the idea of a suspension bridge the picture of a free swinging pendulum. The weight of the superstructure, without cables, will be 2675 tons. Now, the supporting

power of the stays alone will be 15,000 tons, ample to hold up the floor. If the cables were removed the bridge would sink in the centre, but would not fall. To uphold the centre of the bridge, to provide for greater strength and security, and to maintain the integrity of the whole, the four cables are added. If a rigid economy was to be exercised for want of capital, less strength and stiffness might answer. By a reduction of weight and of strength, a great deal of expensive material and work might be saved. But in the same proportion would the stiffness of the work be also decreased, and its safety in the case of a great hurricane less insured. The great features of the work will be the two towers. The base of each tower at the water-line, measured in the direction of the river, is 134 feet long, and its extreme width will be 50 feet. Below the upper cornice, at the top of the tower, these dimensions are reduced to 120 feet by 40 feet. This reduction is not effected by a gradual drawing in or sloping, but by sloped offsets at intervals, which leave the intermediate portions of the masonry plumb face. The elevation of the floor is 118 feet above high water; the height of the roofing above the floor is 150 feet, making a total height of 268 feet from high water to top of roof, not including the balustrade and ornamental blocks. This large body does not form one solid mass, but is built hollow. Two large openings, or well-holes, each 31½ feet by 20 feet wide, are left open in the masonry below the floor; and these openings are continued 120½ feet above the floor, in the form of pointed arches. The shafts are provided with projecting buttresses, for the purpose of saving masonry, to gain strength and to improve their architectural appearance. In a work of such magnitude, and located as it is between two great cities, good architectural proportions should be observed. No expensive cutting, however, will be required in this masonry. The character of the facing will be that of rock-work below the floor. Above the floor a draft will be cut around the margin of each stone, and the face between will be simply cut down to an uniform but projecting level. The impression of the whole will be that of massiveness and strength. It is proposed to face all the outside with dimension stone of granite; the inside, or backing, will be rubble and concrete. Starting with the masonry 3 feet below low water, the cubical quantity in the two towers will be 62,824 cubic yards of 27 cubic feet each. The foundations for the support of these large masses of masonry must be unyielding. Solid rock bottom is preferable to any other; but if such cannot be found at a reasonable depth,

then other means must be resorted to to make the bottom secure. The cubic contents of one tower is 31,412 cubic yards, equal to 848,124 cubic feet, which at 160 pounds weigh 135,699,840 pounds, or 67,850 tons. Add to this the greatest weight of superstructure and load of 4753 tons, and we have a total of 72,603 tons net. Now, the area of base at water-line is 4660 superficial feet, and therefore the pressure upon each superficial foot will be 15·58 tons. It is important that this great pressure should be spread as much as possible over a large area. This can be done by enlarging the base of the masonry itself, either by solid stone or by concrete. But neither of these methods is as good and trustworthy as is a heavy, solid timber foundation. I propose, therefore, to lay down a solid timber platform, with its lower base enlarged to 174 feet in length by 66 feet in width, and of a depth of about 20 feet or more. The area of the lower base will therefore be 16,704 superficial feet, and the superincumbent pressure will be reduced from 15½ tons to 4¼ tons per superficial foot. Now, a pressure of 3 to 4⅓ tons per superficial foot of foundation is an ordinary and usual weight, imposed upon railroad bridge foundations, with piers of 50 to 60 feet high, and such a pressure will always be considered safe and secure on a bed of compact gravel or sand, provided there is no danger of undermining and spreading sideways. The location of the anchorage, on the New York side, will be in the block bounded by Cherry, Water and Dover, one side facing the latter. The Brooklyn anchorage will be located in James Street and part of an adjoining block. The anchorage will not form one solid mass, but there will be two large open spaces left in each wall. I will add here a few remarks explaining how these spaces can be improved and utilized to an excellent purpose, so as to bring a high rate of rent. By arching and iron flooring, eight rooms may be formed in each anchorage, each over 70 feet deep, 15 to 20 feet wide, and about 20 feet high. By being converted into treasury vaults, for the safe keeping of all kinds of treasures and securities, these vaults will possess unequaled claims, not only for the city of New York, but for the whole country and the whole continent. No city in the world would possess treasury vaults of equal strength, safety and security against fire as well as burglary. By a small additional expenditure absolute safety may be obtained in every respect.

(To be continued.)

Mechanics, Physics and Chemistry.

WILD'S MAGNETO-ELECTRIC MACHINE.

We have just received from Mr. Wild a copy of his paper, entitled "Experimental Researches in Magnetism and Electricity," read before the Royal Society, April 26th, 1866.

Having published in vol. lii., page 400, of this *Journal*, paper by William Crooks, containing a full description of Mr. Wild's machine and detailed drawings of its several parts, we will at present confine our notice to a few important points only which were not there mentioned. In the first place, we find in Mr. Wild's original paper an explanation of the *raltionale* of his machine, which we think it well to put on record.

After a minute description of the apparatus and experiments, by which it was shown that a current could be obtained from the coil of an electro-magnet which had been powerfully excited, for a sensible time (as much as 15 seconds even) after the original or exciting current had been thrown off, Mr. Wild continues: "That an electro-magnet possesses the power of retaining a charge of electricity, in a manner analogous to that in which it is retained in insulated submarine cables and in the Leyden jar, but not identical with it, is evident from the appearance of a spark at the point of disjunction of the wires a considerable time after all connection with the electromotor has been cut off. The production of this spark appears to me to arise from the comparatively slow manner in which large masses of iron return to their normal condition after having attained a highly exalted degree of magnetism; the rate of decrease, however, being sufficiently rapid to allow the induction current to manifest itself in the electro-helices, with a decreasing intensity, simultaneously with the decreasing flux of magnetism in the iron itself.

"It is this important retentive property of the electro-magnet which maintains its attractive force unimpaired, notwithstanding the intermittent character of the electricity transmitted through the electro-helices; for, as is well known, no current whatever is produced from the armature of the magneto-electric machine when in certain positions during its revolution. These positions correspond, in some measure, with the dead points of the crank of a steam-engine, the fly-

wheel of which performs the same function *dynamically*, as that which the electro-magnet performs *statically*, in the case of the magneto-electric machine.

"That the charge retained by the electro-magnet is, as has already been observed, much more powerful than that which the magneto-electric machine is of itself capable of producing, is evident from the severe shock which is felt when the body forms part of the circuit, and also from the more voluminous spark which appears at the point of disjunction of the wires when contact with the machine is broken.

"That this increase of electric force in the electro-magnet is the consequence or effect of a certain number of electrical waves transmitted through the electro-helices, and succeeding each other with sufficient rapidity to sustain the increasing flux of magnetism in the iron, is manifest from the time which elapses before the electricity transmitted through the helices attains a permanent degree of intensity, and before the electro-magnet acquires its greatest amount of magnetism (45).*

"That the length of time which was observed to elapse, and the number of waves which required to be transmitted through the electro-helices before the current from the magneto-electric machine attained a permanent degree of intensity, and the electro-magnet acquired its greatest amount of magnetism, are dependent upon the magnitude of the waves of electricity transmitted through the electro-helices, is evident from the fact that the same degree of intensity of the current (as measured by the balance), and the same amount of magnetism in the electro-magnet, were obtained with a much smaller number of waves, and in a shorter time, from a large electromotor (46). These observations will be further confirmed by experiments to be hereafter adduced."

Another quotation we will also insert, as a matter of justice to Mr. Wild, since the inaccurate statement which he here corrects is found in the article above referred to. In a note on page 101 Mr. Wild remarks: "Since the publication of the abstract of this paper in the Proceedings of the Royal Society, my attention has been directed to several accounts of experiments in which electro-magnets, excited by means of magneto-electric machines, have been made to sustain considerable weights. The most important of these accounts which have come under my notice, is one contained in *Silliman's Journal of*

* Philosophical Transactions, 1846, page 6.

Science for 1845, vol. xlviii., page 393, in which it is stated that Dr. Page, by means of a magneto-electric machine, made an electro-magnet sustain a weight of 1000 pounds.

"Another account to which I have been referred, is contained in a treatise on the Electric Telegraph, by M. l'Abbé Moigno, Paris, 1849, in which it is stated (page 15, page 72 in the second edition) that the Abbés Moigno and Raillard, by means of a small machine, made an electro-magnet sustain a weight of 600 kilogrammes.

"In neither of these accounts, however, does any direct comparison appear to have been made between the sustaining power of the permanent and the electro-magnets, as no mention is therein made of the sustaining power of the permanent magnets, nor are they (the permanent magnets) specifically mentioned.

"In a brief notice of my experiments which appeared in *Les Mondes* of September 6th, 1866, of which journal M. Abbé l'Moigno is the editor, he gives what professes to be a quotation from his *Traité de Télégraphie Electrique*, in which he has introduced a statement specifying the sustaining power of the permanent magnets used in his experiments, although no such statement is to be found in the treatise from which the quotation is taken.

"Another discrepancy with reference to the account of Moigno's experiments also occurs in an article on "Wild's Magneto-Electric Machine," in the *Quarterly Journal of Science* for October, 1866, in which the writer would seem to have mistaken a small electro-magnet (used only as an adjunct to a magneto-electric machine, and which Moigno states would only support a few grammes) for the permanent magnets which excited the electro-magnet; and from this error, it is made to appear that the permanent magnets used by Moigno would only sustain a few grammes.

REPORT UPON THE EXPLOSION OF A DENSMORE BOILER,

AT No. 259 WEST TWENTY-SEVENTH STREET, NEW YORK, SEPTEMBER 9TH, 1867.

By CHAS. HASWELL.

NEW YORK, *September 19th*, 1867.

HAVING, at the request of Coroner John Wildey, examined the boiler of Mr. A. R. Welch, which was in operation upon his premises on the 9th instant, and is now embedded in the house No. 308 West Twenty-fifth Street, we submit the following:

The boiler, in construction, is a vertical fire-tubular return, the products of combustion ascending within the furnace to the upper end of a tube chamber, and then passing downwards through a nest or series of tubes to the chimney.

The design of the boiler is of a type that gives a rapid generation of steam with a small volume of water.

The ordinary working pressure to which this boiler was submitted is alleged to have been 60 pounds per square inch (mercurial gauge).

From the construction of the tube-chamber, and the arrangement of the tubes, it was impracticable to move all the sediment or scale that was deposited between the tubes and upon the lower tube-head.

The amount of force, involving the rupture, may be estimated from the horizontal distance of 360 feet, to which the boiler, weighing 10,000 pounds, was projected, and the elevation due to that projection: The angle of flight, necessarily exceeding 69 degrees, form the intervention of an intervening wall of a building.

The plates with which the boiler was constructed were of a very irregular texture, many portions of them being laminated and imperfect in their structure, and consequently unsuited for the purpose to which they were applied.

Reviewing, then, the elements submitted, we are of opinion—

1st. That the ordinary working pressure of steam of 60 pounds per square inch, when the horizontal direction of the pivot-rupture in the furnace is considered, was not sufficient to produce the results referred to.

2d. That, from indications perfectly reliable, there was water in the boiler at the time of the rupture, but to what height it reached it is wholly impracticable for us to determine.

3d. That that portion of the cylinder or chamber enclosing the tubes, which was exposed to the fire of the furnace, and of the lower portion of the tubes, it is clear that they have been lately unduly heated in consequence of their being encrusted and enclosed with scale or sediment.

4th. That the type of the boiler is one which invites constant attention, much experience and good judgment in directing its operation; that it is an unsafe one, and is therefore essentially unsuited for operation contiguous to a foundation or supporting wall of a building.

Finally. That the boiler was ruptured by a force exceeding that due to the required working pressure, but whether this undue pressure was the result of an accumulation of steam, from the inspection of the

safety-valve or fire, the rapid generation of a large volume of it, from the sudden contact of water, entered either by the feed-pump or carried by foaming, with a volume of superheated steam, we are, from the insufficient character of the elements observed, unable to arrive at a definite conclusion.

From the London Engineering, August, 1867.

NEW MODES OF MAKING STEEL.

THE Paris Exhibition is particularly rich in specimens of steel obtained direct from pig iron or iron ore by certain new methods of conversion, recently invented, partly with an intention of avoiding Mr. Bessemer's patents, and partly also with an idea of removing from the iron the noxious admixtures of sulphur, phosphorus and other elements which have proved unassailable by the Bessemer process, and by most of the other methods adopted for making steel. We have already noticed Mr. Siemens' new plan of making steel direct from the ore in a regenerative gas furnace, and we have noted other applications of the Siemens furnace to the manufacture of cast steel direct. There are two inventions of this kind in the French department, both represented by some very fine specimens of steel, made by a direct process in the Siemens furnace, and without crucibles. The two inventors, we believe, are now involved in a lawsuit for infringement of patents, although it is difficult to see how either of the two can substantiate any claims, with the exception of more or less unimportant details.

The two inventors are M. Berard, of Paris, whose operations are carried out at Montataire, and Messrs. Emile and Pierre Martin, of Paris, the well-known proprietors of the forge at Sireuil, France. M. Berard has the idea of exposing his pig iron to a protracted series of alternative decarburizations and recarburizations. He works a quantity of molten pig iron in a Siemens furnace, through which an oxidizing current of heated gases, or a flame containing a surplus of air, is passed. The oxygen of the air is thus enabled to act upon the impurities contained in the iron in the same manner as it does in the Bessemer process. After continuing this action for a certain time, M. Berard reverses the process, that is, he introduces a flame which contains a surplus of gas, and is, therefore, capable of parting with some of its carbon, so as to restore it to the liquid iron. By this alternating process M. Berard believes that he is in a position to protract the process of conversion to any desired length of time, and to give the oxygen an opportunity of removing from the mass a greater quantity of impurities than can be got rid of by the Bessemer process. M. Berard makes use of the changes of current required for working

the regenerators of the Siemens furnace for effecting his alternating operations. He divides the furnace into two halves, each forming a receptacle for a quantity of molten pigs, the two compartments being separated by a bridge made of fire-bricks. The flame entering the furnace at one side, must pass over one mass of iron before it can reach the bridge, and after that it passes over the second charge of iron. The oxygen of the flame is taken up by the carbon contained in the first bath of iron, and the flame is thereby made a reducing one before it passes the bridge; the latter is sometimes also covered with pieces of coke or charcoal, so as to add still more carbon to the composition of the flame before it passes over the second bath of molten iron. The process is usually carried on so as to have fresh pig iron on one side, while a nearly decarburized material is contained in the second compartment, one change of currents only being made. The fresh flame, therefore, always passes over the crude pig iron first, and afterwards reaches the decarburized mass, which it converts into steel. M. Berard is very far from having as yet got his process into anything like a practical working condition. The small quantity of good steel he has produced hitherto, is the pick of a disproportionate amount of failures, and to all those who are acquainted with the difficulty which exists in removing sulphur and phosphorus from the iron by the oxidizing influence of the air, it must appear extremely unlikely that the means resorted to by M. Berard, however protracted their action may be, can effectively serve the purpose for which they are intended. M. Berard also intends to add mixtures of wrought iron, steel scrap and other similar matter to his pig iron, but for this he has no special claim as an inventor, the process of mixing pig iron with decarburized iron, or with iron ore, being very old and universally known. Messrs. Emile and Pierre Martin have introduced a system of steel manufacture which is of far greater practical value and importance, although it contains no more novelty in its abstract principle than the first-named process. Messrs. Martin, however, have succeeded in making their process a commercial success. The Martin process is now in operation at the works of Messrs. Schneider & Co., at Creusot, at Messrs. Verdie's, at Firmini, and in three or four other French steel works, and its results are very satisfactory, both with regard to the quality of steel produced and to its economical production. Messrs. Martin's mode of operation consists in the following process: A quantity of pig iron, say a charge of 3 or of 5 tons, is melted in a Siemens furnace with a dish-shaped bottom, or it is run into the furnace from a cupola or blast furnace. It is then exposed for about half an hour to a very high temperature, care being taken to keep the flame slightly overcharged with gas, by which means the burning of the fire-bricks of the furnace top is said to be avoided or lessened. After that time a quantity of wrought iron, scrap steel, scrap or iron ore, or a mixture of these substances, is added to the mass. These additions are repeated in intervals of about thirty minutes, and they are made at charges of about 2 cwt. at each time. The articles charged into the

furnace are all previously heated to redness, so as to avoid any cooling influence upon the liquid mass. The process continues in this manner for about six hours. Towards the end of the operation the temperature of the furnace is raised as far as the nature of the combustion will permit. The quality of the metal produced is carefully tested from time to time, by removing a small quantity of metal from the furnace, and casting it into a small ingot mould, the ingot being tried afterwards under the hammer. The operator has thereby at all times complete control over the course of the process. He can judge how near the product obtained at any given moment comes to the desired quality of steel, and he can adjust his operations and additions accordingly. Messrs. Martin have found it advisable, in the production of steel, to follow the same course as has been adopted in the Bessemer process, viz: to decarburize the iron completely at first, and then to add a sufficient quantity of spiegeleisen, to effect the desired combination of iron and carbon. In M. Martin's process the facility for working up old iron and steel scrap is a very important point. The conversion of old iron rails and of similar articles into steel has become a great desideratum in our recent practice. In the Bessemer process this is feasible, but the proportion of wrought iron which can be added to the pig iron in the converter is comparatively small, and any excess endangers the proper fluidity of the charge. The largest proportion of wrought iron that has, to our knowledge, been added to a charge in the Bessemer converter, was thirty per cent. of old rails mixed with very gray hematite; but then the rails were thrown into the converter at a welding heat, and the pig iron run upon them immediately. M. Martin says that he can use two-thirds of old rails with one-third of pig iron without difficulty, only the rails must be of good iron, free from sulphur and phosphorus, since the Martin process will no more remove these elements from the iron than the Bessemer process will. Messrs. Martin have produced the same graduation of metals containing more or less carbon, in proportion as has been obtained by the Bessemer process. They make a "mixed metal," half cast iron, half steel, the same as Mr. Bessemer uses for his hammer heads and anvils. They produce tool steel of remarkably good quality, also soft steel, or homogeneous metal, and ultimately the very softest kinds of decarburized iron, to which they have given the name *fer fondu*, or "cast wrought iron." This latter substance is somewhat similar in its nature and appearance of fracture to the homogeneous iron shown in the exhibitions of several iron-works in the British section. Messrs. Martin's process seems to be worthy the attention of British steel-makers, and it is very likely to come in as a very useful addition to the Bessemer process for working up scraps and old materials into marketable steel.

THE FLOW OF STEAM AND OTHER ELASTIC FLUIDS.

By Eli W. Blake.

In the *Journal of the Franklin Institute* for September, 1867, under the head of "Engineering Items," occurs the following item:

"*The Velocity of Steam.*—In the *Mechanics' Magazine*, page 271, we find noticed a pamphlet by R. D. Napier, on the above subject, which we hope before long to have the opportunity of examining.

"Two of the most remarkable statements in this pamphlet are given in the above notice, and are said to be well supported, not only by clear reasoning, but by careful and repeated experiment. These propositions are certainly worthy of note, and, if substantiated, will introduce some marked changes in our received formulæ. They are as follows:

"First. The greatest rate at which steam will flow from an orifice into a vacuum, is only half of that generally stated and given in the tables published on this subject.

"Second. Steam or any other gas, at a given pressure, will rush into any pressure less than half its own, exactly as into a vacuum. Thus, steam of anything over two atmospheres will escape into the air or into a vacuum at the same rate. We have not the essay in question before us, and therefore can form no judgment of its force or reliability. We can merely state the proposition as above, and repeat that the writer in the journal quoted speaks of them as well and clearly substantiated."

The object of this communication is to direct the attention of those interested in the subject to which the above item relates, to an article contributed by me twenty years ago to the *American Journal of Science and Arts*, and published in that journal, vol. v., second series, page 78.

In that article the propositions above accredited to R. D. Napier, were fully stated and proved by the most rigid and conclusive mathematical reasoning; and the true law was given for the flow of steam or other gases under all possible relations of the densities in the discharging and receiving vessel.

Soon after the publication of the article, I called to it the attention of the then editor of the *Journal of the Franklin Institute*, as developing truths of much practical importance, and desired its publication in this journal in order that it might reach a larger number of practical engineers than it was likely to reach through the pages of the

American Journal of Science and Arts; but I was informed that it was not in accordance with the plan of this journal to reprint articles which had already appeared in other journals.

Three years after the publication of the article, having, in the meantime, learned that several of the most eminent mathematicians in this country, after reading it, had, without further examination, pronounced it unsound, on the ground that it was incredible that the elastic force of the steam in the receiving vessel should not, *under all circumstances*, have the effect to diminish the flow through the orifice, I devised and carried into effect a plan by which, in a single experiment, the law could be tested throughout its entire range, and in a manner perfectly unexceptionable and conclusive.

An account of this experiment and its results was given in the *American Journal of Science and Arts*, vol. xii., new series, page 186, and I venture to say that never was a physical law, deduced by pure mathematical reasoning, more fully and completely proved by experiment than in this case.

New Haven, September 18th, 1867.

From the London Journal of the Society of Arts, June, 1867.

SUGAR FROM STARCH.

"AN interesting fact has been communicated to us," says the *Journal des Fabricantes de Sucre*, "by one of our correspondents in Canada, who, contrary to the results obtained in the United States, has effected at Montreal the complete conversion of the starch of maize and of cellulose into sugar. Little dextrine and strong crystals were obtained. There was a large quantity of this maize sugar manufactured at Mr. Molsen's refinery, in New York, last year, and crystallized with cane sugar, and delivered to the trade without any complaint, or the slightest suspicion that it partly consisted of sugars manufactured from cereals. A patent has been taken out in Canada, and another in the United States, and the inventor is actively engaged in following up this curious discovery, which, if successful, will add another to the different sources of sugar production." On this the *Produce Markets Review* observes: "It may be visionary on our part, but we cannot help thinking that the manufacture of crystallizable sugar from starch is one of the great chemical discoveries which will some day or other revolutionize commerce. We should then be dependent neither on the beet nor on the cane, but every country would be in a position to manufacture sugar from almost all vegetable products. The trade in potato or starch or glucose sugar is already a large one in Germany, and if the sugar could be crystallized its development would be vast."

SOLUTION OF CHLORINATED MAGNESIA.

By Robert F. Fairthorne.

Thinking that this preparation, from the possession of certain properties, has advantages over the chlorinated solution of soda, known by the name of "Labarraque's Disinfecting Liquid," I would suggest the following simple formula for making the same: Dissolve 8 ounces sulphate of magnesia in two pints of water. Triturate in a mortar 4 ounces and 1 drachm of chlorinated lime with an equal amount of the same fluid. Mix the solutions together and agitate occasionally.

After standing twelve hours pour off the supernatant liquid.

This consists of a solution of chlorinated magnesia containing a small amount of sulphate of lime. I found by adding solution of caustic soda that the precipitate produced thereby from 4 ounces of the liquid, when dried, weighed 35 grains; therefore each ounce contains a little less than 9 grains of magnesia.

The superiority over the corresponding solutions of soda and lime as a remedial agent, consists in the base (magnesia) which it contains not being caustic in its nature. Therefore particularly adapted either for internal use or as an application to delicate tissue where the effect of chlorine or its compounds only is required.

From the Monthly Notices of the Royal Astronomical Society, March, 1867.

ON THE SPECTRUM OF MARS, WITH SOME RESEARCHES ON THE COLOR OF THAT PLANET.

By William Huggins, Esq., F. R. S.

On several occasions during the late opposition of *Mars*, I made observations of the spectrum of the solar light reflected from that planet.

The spectroscope which I employed was the same as that of which a description has appeared in my former papers.* Two instruments were used, one of which is furnished with a single prism of dense glass, which has a refracting angle of 60°. The other instrument has two similar prisms.

In a paper "On the Spectra of Some of the Fixed Stars," by my-

* "On the Spectra of Some of the Fixed Stars." *Phil. Trans.*, 1864, page 415. During my prismatic researches I have tried, and used occasionally, several other arrangements for applying the prism to the telescope. Some of these instruments are fitted with compound prisms, which give direct vision. I have not found any apparatus equal in delicacy and in accuracy to that which is referred to in the text.

self and Dr. W. A. Miller, we state, that on one occasion several strong lines of absorption were seen in the more refrangible parts of the spectrum of *Mars*.

During the recent more favorable opportunities of viewing *Mars*, I again saw groups of lines in the blue and indigo parts of the spectrum. However, the faintness of this portion of the spectrum, when the slit was made sufficiently narrow for the distinct observation of the lines of Fraunhofer, did not permit me to measure with accuracy the position of the lines which I saw. For this reason I was unable to determine whether these lines are those which occur in this part of the solar spectrum, or whether any of them are new lines due to an absorption which the light suffers by reflection from the planet.

I have confirmed our former observation, that several strong lines exist in the red portion of the spectrum. Fraunhofer's C was distinctly seen, and its identity determined by satisfactory measures with the micrometer of the spectrum apparatus. From this line the spectrum, as far as it can be traced towards the less refrangible end, is crossed by dark lines. One strong line was satisfactorily determined by the micrometer to be situated from C, at about one-fourth the distance from C to B. As a similar line is not found in this position in the solar spectrum, the line in the spectrum of *Mars* may be accepted as an indication of absorption by the planet, and probably by the atmosphere which surrounds it. The other lines in the red may be identical, at least in part, with B and a, and the adjacent lines of the solar spectrum.

On February 14th, faint lines were seen on both sides of Fraunhofer's D. The lines on the more refrangible side of D were stronger than the less refrangible lines. These lines occupy positions in the spectrum apparently coincident with groups of lines which make their appearance when the sun's light traverses the lower strata of the atmosphere, and which are therefore supposed to be produced by the absorption of gases or vapors existing in our atmosphere. The lines in the spectrum of *Mars* probably indicate the existence of similar matter in the planet's atmosphere. I suspected that these lines were most distinct in the light from the margin of the planet's disk, but this observation was, to some extent, uncertain. That these lines were not produced by the portion of the earth's atmosphere through which the light of *Mars* had passed, was shown by the absence of similar lines in the spectrum of the moon, which, at the time of observation, had a smaller altitude than *Mars*.

I observed also the spectra of the darker portions of the planet's disk. The spectrum of the dark zone beneath the Southern Polar spot, appeared as a dusky band when compared with the spectra of the adjoining brighter parts of the planet. This fainter spectrum appeared to possess an uniform depth of shade throughout its length. This observation would indicate that the material which forms the darker parts of the planet's surface, absorbs all the rays of the spectrum equally. These portions should be therefore neutral, or nearly so, in color.

I do not now regard the ruddy color of *Mars* to be due to an *elective* absorption, that is, an absorption of certain rays only so as to produce dark lines in the spectrum.

Further, it does not appear to be probable that the ruddy tint which distinguishes *Mars*, has its origin in the planet's atmosphere; for the light reflected from the polar regions is free from color, though this light has traversed a longer column of atmosphere than the light from the central parts of the disk. It is in the central parts of the disk that the color is most marked. If, indeed, the color be produced by the planet's atmosphere, it must be referred to peculiar conditions of it which exist only in connection with particular portions of the planetary surface. The evidence we possess at present, appears to support the opinion that the planet's distinctive color has its origin in the material of which some parts of its surface are composed. Mr. Lockyer's observation, that the color is most intense when the planet's atmosphere is free from clouds, obviously admits of an interpretation in accordance with this view.

This opinion appears to receive support from the photometric observations of Seidel and Zöllner, some of the results of which I will briefly state.

These observations show that *Mars* resembles the moon in the anomalous amount of variation of the light reflected from it, as it increases and decreases in phase; also in the greater brilliancy of the marginal portions of its disk. Further, Zöllner has found that the albedo of *Mars*, that is, the mean reflective power of the different parts of its disk, is not more than about one-half greater than that of the lunar surface. Now, these optical characters are in accordance with telescopic observation that in the case of *Mars*, the light is reflected almost entirely from the true surface of the planet. *Jupiter* and *Saturn*, the light from which has evidently come from an envelope of clouds, are, on the contrary, less bright at the margin than at the central part of the disk. These planets have an albedo, severally, about four and three times greater than that of the moon.*

The anomalous degradation in brightness of the moon at the phases on either side of the full, as well as the greater brilliancy of the limb, may be accounted for by the supposition of inequalities on its surface, and also by a partly regular reflective property of its superficial rocks. Zöllner has shown that if these phenomena be assumed empirically to be due to inequalities, then the angle of mean elevation of these inequalities must be taken as 52°. On the same hypothesis, the more rapid changes of *Mars* would require an angle of 76°.†

It appears to be highly probable that the conditions of surface which give rise to these phenomena are common to the moon and to *Mars*. The considerations referred to in a former paragraph suggest that

* *Photometrische Untersuchungen*, von Dr. J. C. Zollner, Leipzig, 1865.

† *Photometrische Untersuchungen*, von Dr. J. C. Zollner, Leipzig, 1865, pages 113 and 128.

these superficial conditions represent peculiarities which exist at the true surface of the planet. In this connection it is of importance to remark, that the darker parts of the disk of *Mars* gradually disappear, and the colored portions lose their distinctive ruddy tint as they approach the limb.

The observations of Sir John Herschel* and Prof. G. Bond† give a mean reflective power to the moon's surface, similar to that from a "gray, weathered sandstone" rock. Zöllner has confirmed this statement. According to him—

The albedo of the	Moon	= ·1736	of the incident	light.
"	"	Mars	= ·2672	"	"
"	"	Jupiter	= ·6238	"	"
"	"	Saturn	= ·4981	"	"
"	"	White paper	= ·700	"	"
"	"	White sandstone	= ·237	"	"

From this table it appears that *Mars* takes in for its own use ·7328 of the energy which it receives as light. *Jupiter's* cloudy atmosphere, nearly as brilliant as white paper, rejects more than six-tenths of the light which falls upon it. Therefore, less than four-tenths of the light which this distant planet receives is alone available for the purposes of its economy.

The photographic researches of Mr. De La Rue and others show that the rays of high refrangibility, which are specially powerful in producing chemical action, are similarly affected.‡ At present we know nothing of the reflective power of the planets for those rays of slower vibration which we call heat.

From the Chemical News, August, 1867.

ON THE INACTIVE CONDITION OF SOLID MATTER.

In the *Chemical News* for November 30, 1866, we gave an account of some remarkable experiments by M. Gernez, as recorded in the *Comptes Rendus* for 19th November, 1866. It is well known that when a solid body, such as a glass rod, is introduced into soda water, seltzer water, or other supersaturated solutions of a gas, it becomes immediately covered with gas bubbles, and even effervescence may set in. The rod, however, becomes inactive after a short time, or it may be made so by previously immerging it in water, or by heating it in the flame of a spirit lamp, or by keeping it out of contact with

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* *Outlines of Astronomy*, page 272.

† "On the Light of the Moon and *Jupiter*," *Memoirs American Academy*, vol. viii., page 222. In the same *Memoir* Prof. G. Bond estimates the albedo of *Jupiter* to be greater than unity. This estimate would require the admission that *Jupiter* shines in part by native light. Ibid., page 284.

‡ Prof. G. Bond states that "the moon, if the constitution of its surface resembled that of *Jupiter*, would photograph in *one-fourteenth* of the time it actually requires." Ibid., page 223.

air. The theory is that it is not the solid that disengages the gas from its solution, but the air in contact with such solid. The inactive solids become active if exposed to the air for a quarter of an hour or an hour. Every solid, however smooth, is covered with roughness that form a sort of net-work of capillary conduits, into which surrounding gases penetrate and condense; and the gas bubbles thus imprisoned act as centres of force in liberating gas from solution. The rougher the body the more brisk the effervescence. The disengagement of gas ceases in time, since each bubble carries with it a portion of the gas which produced its liberation. Heat expels the gas from the surface of the solid by expansion, and immersion in water, by solution.

In order to support this view, the author relies upon the following experiment: "I introduced into a supersaturated aqueous solution of carbonic acid an almost capillary tube, closed at one end and inverted like a gas-jar, and containing air. I had previously deprived this tube of the property of liberating gas. Immediately after immersion, gas adhered to the column of air which the tube contained, forming quickly a large bubble, which was disengaged; then another was produced, and so on. The gas formed then only at the point where the liquid touched the column of air. From this experiment, which I have varied in several ways, it may be concluded that air liberates carbonic acid from its aqueous solution." It is further stated that the nature of the gas is of no consequence, for "supersaturated solutions lose their gas under the influence of any gas bubbles whatever."

In the August number of the *Philosophical Magazine*, Mr. Tomlinson, F. R. S., of King's College, combats the above theory, and denies that air or gas has any action in liberating gases from their solutions. The theory that he proposes to substitute rests on the distinction between a chemically clean solid and one that is clean in the ordinary sense of the word. If the solid be chemically clean there is perfect adhesion between it and the solution, and there is no liberation of gas; if the solid be not chemically clean, then the adhesion is imperfect, and there is a separation of gas. If the water is not attracted by the solid, the gas is; for although the rod may not be clean enough for water to adhere to it, yet gas will adhere to a dirty or a greasy rod. If the rod be made chemically clean, it soon ceases to be so by exposure to the air; and this circumstance, according to Mr. Tomlinson, has led the numerous writers on supersaturated solutions of salts, into error as to the action of *nuclei*, &c., in inducing crystallization. If the nucleus be chemically clean, the solution wets it perfectly, and there is no separation of salt from the water; if the nucleus be not chemically clean, the adhesion is differently distributed between the water and the salt, or the water and the gas, and there is a separation. According to this view a chemically clean body which appears to be "inactive," is really most active; while the so-called "active" condition, is really one of imperfect adhesion.

We select a few of Mr. Tomlinson's experiments in support of this novel view, which, if admitted, will throw a great deal of light on a very obscure object:

Experiment 1. Two ordinarily clean test-glasses, A and B, were taken; A was first filled with methylated spirits of wine, and then rinsed with abundance of water. A bottle of soda water was now poured gently into the two glasses. The inner surface of B was profusely covered with gas bubbles, but not a single bubble was seen on the surface of A.

Experiment 2. A glass rod and a platinum spatula were dipped into A and B, and produced abundant effervescence. They were dipped into spirits of wine, rinsed, and again put into A and B. Not a bubble of gas appeared on either surface, except above the points at which the bodies had been made chemically clean, and there numerous gas bubbles appeared. Indeed, it was accurately determined by the formation of these bubbles how far the solids had been dipped into the spirits.

Experiment 3. A rat's-tail file, made chemically clean, did not liberate any gas; but, dried and drawn through the moist hand (experiment 4), it liberated gas abundantly.

In like manner, dry iron filings (experiment 5), that produced effervescence, did not do so after being washed in spirit; when thrown wet into soda water the spirit was, of course, displaced by the liquid, and the filings were wetted by it; and yet there was no liberation of gas.

A wire gauze cage (experiment 7), full of air, was lowered into soda water, and there was no escape of gas so long as the cage was chemically clean; when the cage was handled with dirty hands (experiment 8) and put into the soda water, there was an abundant effervescence.

Experiment 9. A glass rod was heated in oil above 300° F; then wiped with a duster and put into soda water. It was instantly and completely covered with gas bubbles.

Experiment 11. A large fragment of flint was broken into two pieces and put into soda water. Gas was abundantly liberated, except from the two new and chemically clean surfaces, and on them not a bubble was seen.

Experiment 12. A narrow tube, eleven inches long, was kept in spirits of wine for an hour for five inches of its length. It was closed at top, and so lowered into soda water. There was no liberation of gas either from the tube or the column of air in contact with the solution. On removing the finger, the solution ascended the tube, but there was no liberation of gas until the solution touched that part of the tube which had not been immersed in the spirit, and from this gas was liberated both from the outside and inside of the tube. It is remarked that, had M. Gernez made the inside of his tube as "inactive" as he made the outside, he would have seen that the column of air had really no action in liberating the gas.

From the London Mechanics' Magazine, August, 1867.

THE SULPHUR PRODUCE OF ITALY.

THE sulphur mines of Italy have long been famous for their yield, and their present productiveness fully sustains their reputation. They are now producing something like 300,000 tons per annum, which, taken in the crude state, represents a money value of about £1,200,000. But their yield has only become so enormous in the course of years, the average yield for the year 1830 being but about one-tenth of the present yield. The greater part of the above quantity is derived from Sicily; the Romagna, however, commenced to increase the supply some seven years since, and in 1862 was contributing about 8000 tons per annum, and this quantity has since been increased. For the last fourteen years an improved method of separating the sulphur from the accompanying limestone has been successfully practised in Sicily. The separation of the sulphur from gangue is always effected by liquation, the necessary heat for the fusion being obtained by burning a portion of the ore. This operation, which was formerly effected in small cylindrical open kilns, is, by the improved process, performed in heaps, which are often four hundred times the capacity of the kilns. The ore is arranged in a manner similar to that adopted in charcoal burning, the air being excluded by an impermeable covering of earth. The loss occasioned by the formation of sulphurus acid has been greatly reduced by the new process. The production is increased by one-fifth, and the new heaps can be placed in the vicinity of houses and gardens without objection. Under the old system it was necessary to keep the heaps several miles away from dwellings and vegetation. The further advantage of the process is, that the heaps may be fired at any time, instead of large masses of ore being kept in reserve for ignition at a particular season of the year. Beyond this the process, which formerly was one of the most deadly nature, has been converted into one almost free from danger to the workmen.

A large portion of the island of Sicily is occupied by the gypsum and sulphur-bearing formation, which extends from Mount Etna to the neighborhood of Trapani. The rate of productiveness diminishes towards Trapani, Caltanisetta and Girgenti boasting the best mines, Catania and Palermo those next in importance, whilst the least yielding are in the province of Trapani. In Sicily, as well as in the Romagna, the gypsum formation includes limestones, clays which are more or less marly, and beds of gypsum. In the latter rock, as well as in the limestones, the sulphur is found as an uniform or irregular mixture, sometimes concentrated in small parallel seams, and occasionally crystallized. In the latter case it is often associated with sulphate of strontia or celestine. The sulphur occurs in a different manner in the clays and slates, being found concentrated in globular

masses. This method of occurrence is also common to all the sulphur mines of the Continent which are contained in argillaceous strata. Only a small portion of the sulphur obtained is refined on the island, the greater part being exported in the crude state. For commercial purposes it is classified into three general qualities, which are further divided into seven sub-classes. There are about fifty mines at present at work in Sicily, and the number of hands employed is over twenty thousand.

The Romagna Sulphur Mining Company possesses eight mines, five of which are in the province of Forli, Romagna, whilst three are at Monte Feltre, in the province of Urbino and Pessaro, in the Marches. The refined produce is exported chiefly from Rimini, where the refining works are situated, to the principal centres of consumption among the large towns of Italy. Refined sulphur is used in various manufactories for making sulphuric acid, and for several years past a new use has been found for it in the sulphuration of vines. In the course of scientific progress the general process, to which we have already alluded, has been improved in many minor details. But beyond this, an entirely new process is just reported to have been introduced by M. Brunfaut, a Belgian. The average composition of the sulphur stone of Romagna is, for every 100 parts, 30·60 of sulphur, 26·80 of lime, 41·20 of alumina and silica, and 1·40 of water. By the ordinary method of extraction, only 10 of the 30 parts of sulphur are obtained; there is, therefore, a loss of upwards of 20 per cent., which, of course, must influence not only the profits, but also the price of the article. These defects in the system appear to have been completely obviated by M. Brunfaut, who is said to obtain a yield of 25 per cent. instead of 10.

As already observed, the sulphur is contained only in a state of mixture in the Romagna stone, and not being in chemical combination with any substance, is easily separated by fusion. The melting point of sulphur being extremely low, fusion may be effected by hot-air or by steam, instead of in kilns or even heaps, where the excess of heat converts a large proportion of the substance into sulphurus acid. Taking advantage of this property of sulphur, M. Brunfaut employs an apparatus which consists of a horizontal cylinder, containing an archimedean screw throughout its whole length. The cylinder is made to revolve more or less slowly, according to the nature of the mineral to be treated. The sulphur ore is poured in through a funnel at one end of the cylinder, and when it has sufficiently undergone the action of the apparatus it is led out at the other end. The temperature in the cylinder is maintained by hot-air or steam, which is introduced under a pressure of three atmospheres. By this machine 150 cubic metres of the mineral are reported to be disposed of in twenty-four hours. This economical method of extracting sulphur from its minerals is a matter of great importance to Italy, which is so rich in that valuable substance.

From the London Mechanics' Magazine, August, 1867.

THE PETROLEUM TRIALS AT WOOLWICH.

MR. RICHARDSON has just concluded a series of experiments with the petroleum furnace at Woolwich. In these trials pure petroleum was not used, only a small quantity of shale oil, which did extremely well in the first trials. In the late trials, napthaline, creosote (country and town-made, the latter mixed with salt), and residuum tar and grease, were chiefly employed. The trial proved that all the heavy tars and residuum, town-made creosote and napthaline made too much smoke, and required too large an expenditure of steam to use with them. The tar left an ash on the surface of the grate several inches deep. In the late trial, a superheater for the steam was introduced, but both it and the retorts connected with it were nearly destroyed by the flame. It appears that the common service boiler requires more attention than was at first considered necessary to adapt it for burning liquid fuel. It seems, too, that the fuel should be either pure American petroleum, with or without the spirit, or clear British shale oil. The late trial has been considered satisfactory; and from a tabulated statement, which, Mr. Richardson states, was made by the authority of the dock-yard engineer, we learn that the highest evaporation of water per one pound of fuel, with coal, was 7·53; whilst the lowest, with petroleum, was 12·02, the highest being 13·0.

From the London Mechanics' Magazine, August, 1867.

THE AMERICAN LIFE-RAFT "NONPAREIL."

A DARING adventure has been performed by the crew of an American life-raft. These gallant fellows, three in number, brought over the raft from New York in forty-three days. No better evidence could be afforded of the utility of this invention for purposes of saving life at sea. The raft is only 24 feet long and 12½ feet broad, has two masts, and consists of three cylinders, pointed at each end, united together by canvas connections, having no real deck, and is strengthened by boards, slipped under strong iron neck-pieces, the whole kept together by lashing. A water-proof cloth, hung over a boom, closed at each end, affords sleeping accommodation, two at a time, and the third keeping watch. This is fixed on a strong locker, in which the provisions are kept. The raft lay-to seven times from stress of weather, and the last vessel spoken was the *John Chapman*, a week since, from which they were given a fowl, which is still alive and well. They have arrived with thirty gallons of water to spare. They had no chronometer on board, and sailed by dead-reckoning, and corrected their position by vessels they spoke. There is a smaller raft

on deck for use as a boat. The raft has kept perfectly water-tight all the way, not a leak of any sort having occurred. She is fitted with an apparatus for filling the tubes with air. The adventure has been conducted by John Mikes, captain, and a crew of two, named George Miller and Jerry Mallene.

From the London Mechanics' Magazine, August, 1867.

EXPLOSION OF A HOT-WATER BOTTLE.

A FATAL explosion of a hot-water bottle, which took place on the 31st of March, is reported by the engineers of the Manchester Boiler Association, and, though it cannot rank either among those of steam-boilers or household ones, yet, as it resulted in the death of one person, as well as in serious injury to two others, it is of importance socially; while, independently of its effects, it is of interest in a scientific point of view. The bottle in question was of earthenware, of about a quart capacity, and used, when full of hot water, as a bed warmer. It had been put to this service on a previous occasion, when the cork had been tied in with a waxed end, such as is commonly used in shoe-making. When the bottle was wanted again for a similar purpose, instead of being emptied of its cold water and re-filled with hot, it was put, all tightly corked, into the oven of a kitchen range, to be heated up entire. In a short time a violent explosion ensued: the bottle was burst in pieces, a corner of the oven door split off, and the fragments of iron and earthenware thrown into the room with so much force that three persons were seriously injured, one of them, a child, dying the day after. The circumstances forbid the explosion being attributed to any other cause than quiet internal pressure from the gradual accumulation of steam, which, it will be seen, did not quietly rend the bottle, but violently exploded it. This little incident supports the views expressed in the Association's report for January, 1867, relative to the explosion of household boilers, viz: that they are due simply to excessive pressure, and might be prevented by an efficient safety-valve.

From the London Mechanics' Magazine, August, 1867.

TREATMENT OF GELATINE AND GUM.

A USEFUL invention, apparently capable of wide application, has recently been patented by Mr. J. W. Swan, of Gateshead. It consists in the use of salts of the sesquioxide of chromium, as, for example, sulphate of the sesquioxide of chromium, or the substance known in commerce as chrome alum, as a means of rendering gelatine or gum (Senegal or Arabic), or compounds containing those substances, soluble in water.

This invention is applicable to various uses; for example, to the fixing of pigments and dyes in printing and dyeing textile fabrics, when the pigment or dye is thickened with gelatine or gum. To the tanning of skins and hides; to the fixing of photographs mounted with gelatine; to the fixing of prints produced in gelatinous ink; to the rendering insoluble of gelatine used as a glaze or varnish, or for the purpose of water-proofing; to the production of sheets of insoluble gelatine, and to the preparation of photographic paper, sized with gelatine or gum. In applying his invention to calico-printing, Mr. Swan either adds a solution of chrome alum, or other suitable salt of the sesquioxide of the chromium to the thickened color or dye, or he applies a solution of the above salt to the textile fabric, either before or after printing; or, where the addition of a chromate or bichromate would not be injurious or incompatible with the mixture of color or dye, instead of the said salt of the sesquioxide of chromium, he adds to the color or dye chromate or bichromate of potash, and, after printing, acts upon it by light, or by citric acid, or other acid suitable for decomposing and reducing the chromate or bichromate, so as to produce the compound of the sesquioxide of chromium required to render insoluble the gelatine or gum contained in the mixture of color or dye. When the fixing solution is applied to the fabric before or after printing, it consists of five parts, by weight, of chrome alum and one hundred parts of water, and when the fixing solution is added to the thickened color or dye, one part of the fixing solution, composed as above mentioned, may be added to every ten parts of the thickened color or dye.

In tanning, the skins or hides are immersed in a solution containing about one per cent. of chrome alum, or in a solution of chromate or bichromate of potash, or other suitable chromate or bichromate. The chromate or bichromate is decomposed in the skin or hide by means of oxalic or other suitable acid, so as to produce, by the decomposition and reduction of the said chromate or bichromate, the required compound of chromic oxide. In fixing prints produced in gelatinous ink, a solution of a salt of the sesquioxide of chromium, by preference chrome alum is added to the gelatinous ink in the proportion of one part of a ten per cent. solution of chrome alum to ten or twenty parts of the gelatinous ink. Or the above solution is applied to the paper on which the print is to be produced, otherwise a chromate or bichromate is introduced into the ink, and the required decomposition of the chromate or bichromate is effected by the action of light or other reducing agent.

In fixing photographic prints mounted with gelatine, the mounted prints are immersed in a solution of a suitable salt of the sesquioxide of chromium, consisting of about one part of the salt to twenty parts of the water, or the prints are mounted on paper wetted with the solution, or a mixture consisting of about ten parts of a solution of gelatine or gum, and one part of the above solution is employed as the cement wherewith the prints are mounted, the mixture being made

immediately previous to the using, in consequence of the tendency of the mixture to solidify after the addition of a solution of chrome alum. In rendering gelatine insoluble when used as a glaze, sizing or varnish for paper, or when formed into a sheet, a solution containing about five per cent. of chrome alum, or other suitable salt of the sesquioxide of chromium, is applied at the gelatinized surface or gelatine sheet, or the surface or sheet is immersed in the above solution, or a sheet is formed from a mixture of a solution of gelatine and the solution of chrome alum. Mr. Swan also proposes to obtain water-proof fabrics by saturating them with a solution of gelatine, rendering the same insoluble by the action of a solution of chrome alum, or other suitable salt of the sesquioxide of chromium.

(Continued from page 191.)

LECTURES ON MINERALOGY.

By THEODORE D. RAND.

LECTURE III.

MINERALOGY AND GEOLOGY OF THE DISTRICT WEST OF PHILADELPHIA, SOUTHWEST OF THE SCHUYLKILL AND DELAWARE RIVERS.

THE Schuylkill River, though one of the boundaries used in these lectures, is not a geological or mineralogical dividing line. The formations on the south do not vary materially from those on the north; the same alluvium borders the Delaware, the primitive rocks rise gently on the east, reaching their greatest elevation in the hill bordering the Chester Valley on the south, the water-shed of the streams flowing into the Delaware. The most prominent physical feature is the deep and narrow valleys through which run Darby, Crum and Ridley Creeks, which resemble closely that of the Wissahiccon. The rocks, well exposed on these creeks, are chiefly gneiss and mica schist. There are, however, several beds of serpentine rock with its accompanying minerals.

Going south from Philadelphia, the first locality worthy of note is near Gray's Ferry, west of the Schuylkill. In this vicinity is much kaolin from decomposed feldspar or albite. In the quarry near the Junction Railroad, on Mill Creek, may be found feldspar, albite and apatite, but all in poor specimens.

Near Darby small crystals of rutile have been found. On the road from Philadelphia to Chester, near the old rope ferry over Darby Creek, and not far from the Lazaretto, is the celebrated locality of

kyanite. The brown or blackish gray variety, probably sillimanite, is abundant in imperfect isolated crystals, in a decomposing mica schist, while, in the bed of the creek, and in the fields in the vicinity, loose masses of the fine blue or colorless variety have been found, excelled probably by none but that from the Tyrol. Occasionally, damourite is found associated with the blue kyanite.

Near Chester are several very extensive quarries, in a hard micaceous gneiss, yielding an admirable building-stone. This gneiss is intersected by veins of highly feldspathic granite, containing very fine crystals of feldspar, tourmaline, beryl and garnet (usually termed manganesian, but really iron garnets), often exceeding an inch in diameter and well crystallized. The largest of these quarries is that on the east bank of Ridley Creek, adjoining the road from Chester to Philadelphia. The upper portion is now worked by Mr. Deshong. Apatite, beryl of fine green color, tourmaline, cryst. feldspar and a mineral resembling saponite, with very poor uranite, occur here. Burk's quarry, on the opposite side of the creek, has yielded fine tourmaline and beryls. At Avondale, on Crum Creek, about three miles from Chester, are three large quarries. One of these, Judge Lieper's old quarry, is on the west bank, and has yielded large and beautifully modified garnets. The other two are on the east bank. One, also Judge Lieper's, north of the bridge over the creek, presents a remarkably fine face of stone. In this quarry a blast was fired about three years ago which loosened from its bed and shattered sufficiently for working up by wedges, &c., a mass of stone estimated to weigh over 6000 tons, much of which was used in the construction of the Chestnut Street Bridge. This quarry yields the finest garnets of this section, and in addition lime-uranite, pitchblende, uranochre and carbonate of bismuth, the last three minerals probably among the rarest found in the United States. These species are rare even here, but one specimen of the latter ever having been found, and very few of the former.

On Chester Creek, opposite Upland, and about a mile and a half from Chester, a mine was opened many years ago with the expectation of finding gold. The vein was of white quartz, containing molybdenite and more rarely molybdic ochre. This mine has not been worked for nearly twenty years, and has been almost forgotten by the residents. It has yielded fine specimens of molybdenite and molybdic ochre, also pyrites and apatite.

About three miles north-west of Chester, near Dutton's Mills, good

specimens of amethyst, bucholzite, staurotide, in small but neat crystals in white quartz, and crystallized mica, are found.

West of Media, near Ridley Creek, and not far from the bridge of the Philadelphia and Media Railroad, is a bed of serpentine, extending from the creek south-westwardly some three miles to Lenni. The vicinity of this bed, at its eastern extremity, is the locality known as Mineral Hill, and yields many curious minerals. There is a deep gully formed by a small stream to the right of the road from Media to the Black Horse Tavern. The very great fall of this stream, probably 150 feet in a quarter of a mile, has enabled it to wash out and leave in its bed masses of rock situated very favorably for the mineralogist.

Very abundant among these is the oligoclase variety of feldspar, or soda spodumene, generally massive, sometimes in crystals, and frequently beautifully opalescent and called moonstone, from the fact that its reflection resembles moonlight. Sometimes this feldspar contains included particles, forming what is known as aventurine feldspar or sunstone. Rarely both the aventurine and opalescent appearance occur in the same mass, forming specimens as interesting as rare. Green feldspar (amazon stone), fine green massive actinolite, anthophyllite, deep green beryl, good graphic granite, carbonate of magnesia, serpentine and the delawarite variety of feldspar also occur.

In a dry gully just north of this, the amazon stone and the sunstone have been found in greater perfection. Several other minerals are reported from this locality, but the above are all that I am able to verify.

South-west from this locality, about one mile, in the valley of a stream, between the Black Horse Tavern and the railroad, fine moonstone has been found, and also chromic iron sand in large quantity, which has been extracted with much profit. These deposits, however, seem to be exhausted. Near this, also, have been found large and perfect crystals of corundum.

About a mile and a half south-west, near Lenni, the railroad passes through a bed of decomposing serpentine, containing veins of actinolite, marmolite and chlorite—the latter occurring in two forms,—one, little altered, somewhat resembling clinochlore, the other, changed from its original dark green to a pale green, bronze yellow or bright silvery color, swelling up remarkably before the blow-pipe, and classed with vermiculite. In some respects, it closely resembles the jefferisite of Brush (an altered mica from the clinochlore locality south of West Chester). At the same place the lennilite of Mr. Lea occurs.

North from Media, about two miles, is another bed of serpentine, forming a hill called, from the color of the serpentine rock, Blue Hill. Here, chrysotile, or fibrous serpentine, occurs, the fibres unusually long, sometimes exceeding 3 inches. This chrysotile is supposed by many to be an amianthus altered into serpentine as the marmolite is undoubtedly hydrate of magnesia thus altered. There is also found green quartz in perfect crystals, chromic iron in octahedral crystals of unusual size, the faces of some measuring $\frac{3}{16}$ths of an inch; also, a bluish green feldspar, the cassinite.

About two miles north-east from Media, in Marple Township, remarkably fine crystals of andalusite, some of large size, have been found, with amethyst, finely colored and of large size; also, tourmaline in small crystals in quartz, chromic iron, quartz crystals, drusy quartz and chalcedony or agate; none fine.

On the road from Philadelphia to West Chester (Market Street) at the crossing of Darby Creek, heavy rock cuttings through gniess and mica schist were made twelve or fifteen years ago, and a few tourmalines and beryls were found.

On the Pennsylvania Railroad, beyond Hestonville, alunogen and iron alum (so-called; the sulphate of alumina and protoxide of iron remarkable from the fact that though a soluble protosalt of iron, it is entirely permanent) effloresce from the rocks, especially during dry weather in summer. About two miles west of Hestonville a porphyritic gneiss, containing numerous crystals of feldspar, is abundant.

On the Reading Railroad, opposite Manayunk, very good stilbite, with heulandite and chabazie, were found in the tunnel of the Reading Railroad; also, a mica in curious wedge-shaped masses, albite, feldspar, beryl, &c.

At the eastern end of the Columbia Bridge there is a vein of very fine crystallized laumonite, with some natrolite, heulandite, and cryst quartz. It is directly behind the large ice-house of Kershow & Hunt, and hence inaccessible at present.

On the Junction Railroad, about a quarter of a mile beyond Girard Avenue, black mica, probably biotite, in large rough crystals, and, more rarely crystals of the black in a white mica (muscovite), or of the white in the black, occur in interesting specimens. The cleavage of the two micas is invariably in the same plane; sometimes separation along the edges of the included crystal is easy, but generally the specimens may be cleaved into the thinnest lamina, preserving the form of the included crystal, and seemingly perfectly continuous. On the

same road, just below the bridge of the Connecting Railroad, occurs a bed of hornblendic schist, curiously distorted by a vein, or rather three veins, of injected granite.

Nearly opposite, in Fairmount Park, at the point known as Turtle Rock, just above the Skaters' Club House, a vein of true syenite has been injected, contorting the gneiss and mica schist, which seem to incline in every direction from it, forming the comparatively rare geological exposure a quaquaclinal dip. Accompanying this is found chabasic, small crystals of apatite, titanic iron and bucholzite.

On the west bank of the Schuylkill are several quarries. One of the oldest of these occupies the present site of Lipp's brewery, and is described in the older mineralogies as Judge Peters' quarry. It was a narrow, very deep quarry, extending from the river bank to what is now the Pennsylvania Railroad. On the other side of the railroad is a very large quarry or series of quarries, which have long been wrought for building-stone. Recently another quarry has been opened on the south-east of the brewery to procure stone for the Connecting Railroad bridge over the Schuylkill. In all these, beryl, sometimes in a remarkably altered and soft condition, tourmaline and cryst. feldspar, sometimes very good and also resembling adularia, occur; but the most remarkable mineral is the lime-uranite, or phosphate of uranium and lime, and the copper uranite, or phosphate of uranium and copper. Both are of rare occurrence in good specimens, but some masses taken from the upper quarry probably equal any ever found elsewhere. The copper uranite is much the rarer—sometimes they are beautifully associated, but in specimens needing a high magnifying power to show them to advantage. This mineral was first discovered by me in the old lower quarry in 1850, in loose crystals. In the upper quarry it occurs as a coating on the gneiss and rarely in the interior. No uranic ochre or pitchblende has been noticed.

In the upper quarries, coatings of black oxide of manganese or wad are found. The same mineral occurs along the Reading Railroad and the Connecting Railroad, north-east of the Schuylkill. The rock is a decomposing mica schist or gneiss covered with gravel of varying thickness, from a few inches to many feet. The lower stratum of the gravel, resting immediately upon the mica schist, is almost invariably coated and sometimes cemented into a coarse conglomerate by this oxide accompanied by oxide of iron and a little cobalt, resembling very closely that (described in the second lecture) from the other extremity of the Connecting Railroad, but containing much less cobalt.

(To be continued.)

From the London Journal of the Society of Arts, June, 1867.

GLYCERINE GLUE.

A GERMAN chemist, M. C. Puscher, has discovered that, if glue or gelatine be mixed with about one-fourth of its own weight of glycerine, it loses its brittleness, and becomes applicable for many purposes for which it is otherwise unfit. M. Puscher uses mixtures of this kind for dressing leather, preparing artificial bones, for giving elasticity to parchment and porcelain, or enamelled paper, and for book-binding. A cement composed of starch, glycerine and sulphate of lime, is said to remain plastic and adhesive, and is recommended for luting chemical and philosophical apparatus, and other similar purposes. Glycerine glue is said to possess many of the qualities of india rubber, and particularly that of erasing the marks of black lead-pencils. If wax be added to a mixture of gelatine and glycerine, and zinc yellow be used as a ground for the application of aniline red, the color produced is said to be brilliant in the extreme.

THE NEW SUSPENSION BRIDGE AT NIAGARA FALLS.

WORKMEN are busily engaged in preparing for an abutment on the American side of the Niagara River for the new suspension bridge which is intended to connect the Canada and American shores at Niagara Falls. This bridge is intended for the accommodation of foot-passengers only, and the public at large will be indebted to the enterprise and energy of such men as Wm. G. Fargo, of this city; Hollis White of Niagara Falls, and John T. Bush, Esq., of Clifton, Canada, for a structure that will give one of the grandest and most imposing views of the Falls. The bridge will be situated but a short distance from the International Hotel on the American side, and the Clifton House on the Canadian side. It will require a span of 1260 feet. The width will be 10 feet, and the height above the water 100 feet. The structure will be of the usual wire cables, resting upon wooden towers. It will be abundantly strong and safe for the purpose for which it is intended. We understand the timbers are all framed, and will be put in place in the shortest possible time.—*Buffalo Courier.*

EDUCATIONAL

(Continued from page 209.)

THE MAGIC LANTERN AS A MEANS OF DEMONSTRATION.

PASSING for the present from Dr. Cresson's form of condenser, which we believe to be the best representative of what is most desirable in a condenser, theoretically accurate, practically successful and capable of the widest range of application, we will next review various forms which are in use, and which possess greater or less merit, in reference to certain applications and special purposes.

The Triplet Condenser designed by Charles T. Chester of N. Y.

This combination consists of three plano-convex lenses, arranged in the following order counting from the light. First. Next the light, a lens of 1¾ inch focal length and 0·73 inch thickness, plain side to light. Next, a lens of 7½ inches focal length, plain side towards the light 0·8 inch thick. Lastly, a lens of 9 inches focal length, with its curved side towards the light, and having a thickness of 0·6 inch.

These condensers are 4½ inches in diameter, and show by practical test an error of spherical correction, amounting to less than 0·25 of an inch, the focus for parallel rays being about 1¼ inch from the back lens. This result is excellent when we consider the shortness of focus, and is the more surprising, because from general considerations, we should not be led to look for a very good result from such a combination.

The practical working of these condensers, however, confirms the good promise elicited by this test. With the magic lantern, they afford an even and equally illuminated disk of light (an object glass, of course, being employed), and by removing the objective and attaching the stage of a microscope in its place, a very excellent result is obtained, especially with low powers. For high powers the use of extra condensers is indispensable with this, as with the former combination, for reasons which will be fully discussed under the head of Microscopic Objectives.

We have made a careful study of the path of rays through these condensers, and find as the general result of work, which is far too

elaborate and space-occupying to be introduced here, that they owe their correctness to the fact that the marginal rays of the first lens, are intercepted by the mounting. These being the most difficult to correct for spherical errors, the work of the combination in this respect is made easier.

This, of course, entails a loss of light as compared with a lens of equal diameter and focus, which converged all the rays falling on its first surface; but when the shortness of focus of this combination is considered, we see that it can afford some loss, and yet yield as much light as any now in use.

Compared with Dr. Cresson's condenser, this has the advantage of using but three lenses in place of four, and the disadvantage that it requires thicker glass and does not admit of those adjustments and changes, which will be mentioned further on in connection with polarized light, &c. For the magic lantern, and simple gas microscope, however, its working is excellent and satisfactory in every respect.

A combination very good for magic lantern purposes, is also made by Messrs. Queen & Co., of this city. It consists of a plano-convex lens, next the light a double convex of pretty long focus in the middle, and a cross lens in front with its greatest curve towards the light. This has a short focus, and though its spherical correction is not very good, this does not notably effect its working with the lantern objectives which are generally in use.

There are many other combinations in use, but none which differ essentially from those already described, or which possess any peculiar merit.

Much has been said in some foreign journals about the advantage of small lenses placed close to the light, in combination with larger ones set at some distance. After many trials we have reached the following conclusion: The heat which a lens can endure without great risk of cracking, limits us to a distance of not less than an inch and a half. At this distance the lens must be small, not more than 3 inches in diameter, to avoid loss of light at the edges, and consequently a field unequally illuminated. When to such a lens are added the others required to give a converging beam, and to correct spherical aberration, the combination will be found to differ but little from such as have been already described, except in the size and position of the first lens. By bringing this nearer to the others, and proportionally increasing its size, we greatly diminish risk of fracture, and get a better correction with but little increase of cost, and this last is

of still less importance, because a little lens, broken frequently and replaced, will soon cost more than a large one which is safe.

If the condensers of a lantern have too long a focus, such an adjunct lens will improve their illuminating power, but if new condensers are to be constructed, we would by no means recommend the selection of such an arrangement.

Diameter of Condensers.

With regard to the diameter of condensers, from a pretty wide experience collected from our individual experiments, and those of others, we have been led to the conclusion, that for the exhibition of ordinary photographic pictures (which are about three inches square), nothing is to be gained by making the condensers more than 4½ to 5 inches in diameter. The greater errors and losses of larger lenses more than compensate for any other advantage.

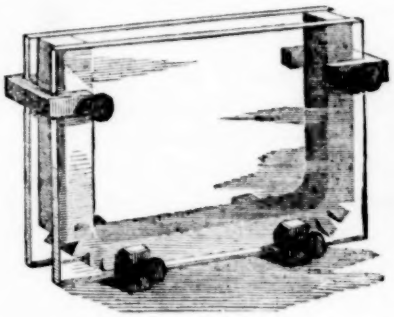
For special purposes, however, large lenses are of great value. This will be best explained by describing the uses to which we have applied a set, of 8 inches diameter, which we have had in use for some time. This combination consists of three bi-convex lenses, the one next the light of 6½ inches, and the others of 8 inches, diameter. The radii of the surfaces, counting from the light, are as follows: First, 10 inches; second, 7 inches; third, 50 inches; fourth, 10 inches; fifth, 50 inches; sixth, 10 inches. Some of the uses to which the lantern provided with these condensers is put, are as follows: At the regular meetings of the Franklin Institute, papers are often read requiring diagram illustrations which may be readily seen by the audience. To supply this requirement, the lantern is set so as to command a screen 12 feet square, over, and in rear of, the lecture table. Diagrams are drawn with india ink on glass plates (6½ by 8½), or still more rapidly by scratching through a film, prepared by coating a plate with iodized collodion, sensitizing, exposing to bright light, and developing. A reserve of these plates is always kept on hand, and diagrams have often been prepared after the beginning of the meeting. The large size of the plate used (resulting from the large size of the condenser) renders it easy to make a drawing involving much detail, and the low power required in the objective by which these pictures are projected, makes them so bright, that much false light is admissible without rendering the image indistinct. Thus, in practice, the lights throughout the room are simply lowered, and four burners on the lecture table are left bright, so that the speaker may read his notes with facility, and

indicate parts of the diagram with a pointer, as if it were a drawing on a blackboard or sheet of paper. With the *scratched* diagrams, the appearance on the screen is that of lines in frosted silver, on a slate-colored ground. The india ink drawings are equally distinct.

An ordinary lantern has been used in the same way for experiment, but the effect was very inferior and unsatisfactory.

Another result of the use of low powers (which is possible in this lantern on account of the large size of the objects and condensers), is the depth of focus secured. This renders it possible to employ as objects, many things of notable thickness which would otherwise be excluded from this use. Thus, for a great number of experiments, tanks, such as the one represented in Fig. 14, may be introduced, and various experiments (to be described in future) conducted in them will be projected with wonderful sharpness, even when the tanks are ¾ inch thick inside. The extent to which this may be carried is curious. Thus, an ordinary hock glass makes an admissible object, both the nearer and further edge showing distinctly on the screen.

Fig. 14.



This same lantern, with such objects, diagrams, photographs, tanks, &c., has covered, at the Opera House, a screen 40 feet square, with admirable effect; the lantern being at the rear of the stage, which is 100 feet deep, and the screen of wet muslin at the first entrance 80 feet from the lantern. The ordinary lanterns, with ordinary sized objects, either fail to cover the screen, or give an imperfect illumination.

(To be continued.)

(Continued from page 213.)

LECTURES ON ELECTRICITY AND LIGHT.

Delivered before the Franklin Institute by Prof. HENRY MORTON, Ph.D.

The Holtz Machine.

IT has been to us a matter of no little surprise, that this wonderful invention has excited abroad so little attention, that a general reader

of scientific periodicals might easily be at the present time quite ignorant of its existence, while even if all that has been published abroad on the subject were collected and studied, the idea gained of the enormous power and wide applicability of this instrument would fall far short of the truth.

We can account for this only by the following considerations and conjectures. These machines, as constructed abroad, are liable to sudden, complete and apparently unaccountable failures, which render them entirely useless until reconstructed; and nothing which has been published in Europe, even by the inventor or constructors of these machines, gives any hint of this failure, its cause or its remedy.

One of these instruments would, in use, then, soon cease to produce good results, and an elaborate course of original investigation would be required, before this failure could be repaired and experiments be continued.

The cause of these failures we were the first to investigate and to localize, and their remedy was discovered only after many experiments. The publication of this will be found in vol. lii., page 420, of this *Journal.*

We also were the first to point out a modification in the form of the instrument, by which repair might be greatly facilitated. Mr. Ritchie, independently, made a similar modification in the machines which he constructs, and Mr. C. Chester was the first to build in this country, and to place in the market, a machine in which this improvement, as well as other important modifications, found expression. See this *Journal*, page 253 and page 344.

It will probably be in this country, therefore, that this instrument (like the Induction Coil in the hands of Mr. Ritchie) will attain its full practical efficiency and the development and first recognition of its vast powers.

Much instruction may be derived from a study of the early stages and growth of this invention, and with that view, and also to place in an accessible form the scattered material for this history, we will enter at some length in a review of the literature of the subject.

One of the earliest notices is found in the BERLIN REPORTS of April, 1865, in which it is stated that a machine had been devised and constructed by M. Holtz, with a view to causing a given quantity of electricity to develop an amount greatly superior to itself. The instrument to produce this effect consisted of a fixed plate glass disk, to which are attached an even number of tinfoil sectors, alternately charged with

opposite electricities, from a small machine of the usual construction. Parallel with this disk, and facing the glass side, is another disk having similar tinfoil sectors on its further side, but being capable of a rapid rotation about an axis perpendicular to its plane. The two disks are, of course, close together. As the sectors of the rotating disks come successively opposite to the positively and negatively charged sectors of the fixed plate, positive and negative electricities are successively driven off from them by induction, and may be collected, transferred, accumulated, and used, by the well-known means and appliances.

The action of this machine is further stated to resemble that of the Induction Coil.

Next to this, in order of development in the instrument described, is to be mentioned a notice in the *Cosmos* for December 20th, 1865, which, being very brief, we will translate here in full. It is as follows:

"**The Holtz Electrical Machine made by M. Ruhmkorff.** —We have seen at the establishment of M. Ruhmkorff, an electrical machine very superior in a practical as well as in a theoretical sense. The apparatus consists of two disks of glass mounted upon glass insulators, both of them thus insulated from metallic connections. One of these plates is movable, the other stationary. The one which is movable has upon its horizontal diameter, a band of paper; this revolves in front of the points of the conductors."

"This description being made, we now turn to the experiments described by M. Ruhmkorff. We electrically excite by friction a rod of hard rubber, and we discharge it upon the band of paper on the movable plate; then we begin moving it. Each time that the paper passes before the points a spark springs between the terminal balls. The effect is continued for a considerable time; then it suddenly ceases. What has taken place? Is it an effect of pure influence? Has it manifested in itself a phenomenon of a new nature? We wait the opinion of other savants to whom M. Ruhmkorff intends to show this curious apparatus, since M. Holtz, the inventor, said himself, that he was unable to fix absolutely upon a theoretical explanation of the phenomenon which he had demonstrated. Happen what will, the phenomenon is most extraordinary. It may supply that link which connects the statical and dynamical forces."

This description is not very clear in itself, and refers to a form of the instrument evidently very imperfect and transitional in its character. It is, however, of interest as indicating one of the steps in the development of this machine.

Next to the above notice in the order of development, is an article on this instrument by its inventor, W. Holtz, of Berlin, published in Puggendorff's *Annalen*, No. 9, 1865, and also translated in the *Philosophical Magazine* for December, 1865.

In this article, the author, after describing the machine, which is substantially identical with that figured and described at page 282, vol. lii., of this *Journal*, proceeds to give an account of its action. The first portion of this explanation is identical with that which we have given in the place above indicated, and will therefore only remark here briefly, that he describes the first paper charged positively by the excited vulcanite, as developing a negative condition in the opposite part of the revolving plate, which negative charge is in part transferred to the paper next in order of rotation, the remainder going to the adjacent collecting points, from which also an opposite charge is received under the influence of the second paper negatively charged as above.

Attention is then drawn to the fact, that the general electrical current in the machine may be regarded as consisting of two currents moving in the same direction, but each having a different origin, and capable of a certain sort of separation under particular conditions.

Thus the direct inductive action of the paper, or element No. 1, causes a flow of its own sort of electricity from the rotating disk to the collecting points, and of the opposite kind from the latter to the former. This may be called the primary current. The charge thus produced on the plate (diminished by such amount as it supplies to the next paper coating) then passes off to the next collector, No. 2, under the influence of this next inducing element.

The relation of these currents, and their effect upon the working of the machine, is then very fully discussed, as follows:

"If we suppose these currents, of which I will call the former the primary and the latter the secondary, to be separated, they must be different, both quantitatively and in their maximum striking distance. In the first respect the primary will exceed the secondary, because the charge of the disk is materially weakened during half a turn; in the latter, on the other hand, an inverse deportment prevails; for the tension of the free electricity on the glass surface is necessarily higher than that which results from its inducing action. But since both currents traverse the same conductor, and one is only a consequence of the other, the cessation of the one, must follow the cessation of the other, and the greatest striking distance of the primary current is, at the same time, that of the apparatus.

"If one of the conductors is connected with the earth, it is only after exceeding the striking distance that the secondary current can disappear, since the coating opposite to it can still electrify the glass disk. In fact, without interrupting this current, the electrodes may be removed to more than double the distance; but this will very soon diminish with the charge of the coating, since no more new electricity is added.

"If there is a jar in the circuit, both currents must simultaneously disappear when the charge has attained a definite amount. The intensity on the coatings of the fixed disk sinks; the jar allows part of its charge to pass on to the rotating disk, and as this, after half a turn, passes to the opposite electrical coatings, in a short time the machine begins to work in the opposite direction. But the jar must in this way continually be charged and again discharged.

"Without a jar, too, inversions of the current may occur, if the maximum striking distance is near, and the fixed disk is only coated on its outside. The opposite electricity then collects on the inside, which remains bound so long as there is a portion of free electricity on the outside. If this latter is lost, either intentionally or unintentionally, the latter begins to act inductively in the opposite direction. It is very inconvenient, that under these conditions the rotation can scarcely be interrupted for a few seconds, without, on beginning it again, the current being found already in the opposite direction.

"By two simple arrangements the machine can be made still more suitable for each special object.

"To keep up the action, independently of the opening of the circuit, it is necessary, as I have stated, to keep the currents separate. The construction might easily be so altered that those currents could only move in separate conductors; but this would do away with the possibility of using them together where it was desirable to do so. It is rather advantageous to avoid the separation until the primary current ceases, and this is effected as follows:

"Imagine a third conductor (the machine here described has but two elements) parallel to the others, and at about a quarter of a turn from them, fastened on the corresponding supports, and the negative coating prolonged to its points, and permanently joined with the further conductor. As long as the striking distance is within definite limits, both currents will, as before, traverse the poles. For even if two conductors are now opposite the lengthened coating, the disk will only be charged by that which precedes it in the direction of the ro-

tation. It is only if the resistance between the poles becomes greater, that the new conductor gradually begins to act, and the primary current will finally only pass between the *first* pole and this new conductor. If now the electrodes are removed, the action of the machine undergoes thereby no interruption. From a certain point the secondary current will indeed disappear, but on the conductors a constant quantity of free electricity will be retained. It is, moreover, not even necessary to prolong the coating, if only that point of the glass opposite the new conductor is touched as often as the machine is set in motion. In this case, or when the rotation is interrupted for a short time, the poles need not be joined. The electrified object must then be approached to the positive coating, in order that the current may be set up immediately between the first pole and the new conductor. The machine gives, in this form, the longest sparks if the first pole and the new conductor are in connection with the ground, and the second pole is connected with a large conductor."

After further descriptions of the apparatus and its effects, such as we have already published, and will not, therefore, repeat in this place, the following new points are mentioned: "At this time I am engaged in the construction of complex machines, which consist of a small machine of the above construction, and a larger apparatus, whose coatings are not kept in electric tension by its own action, but by that of smaller machines."

"Such an one, especially fitted for high tension, was constructed some time ago with disks of 30 inches in diameter."

"There is in this case but one coating without any collecting point attached to it, but charged by the other machine, and having a conducting comb opposite to it, in connection with the ground. Diametrically opposite is an opening in the same fixed plate, opposite to which is placed a collecting comb connected with a large prime conductor. Although the insulation of this apparatus was extremely imperfect, I could obtain with it sparks of 9 inches."

This completes the list of foreign notices of this machine, except such as have been already translated in this *Journal*, as at pages 36, 121, 255, vol. liii., and a description published by the inventor, which is in substance identical with that which we have just quoted.

(To be continued.)

A COMPARISON *of some of the Meteorological Phenomena of* AUGUST, 1867, *with those of* AUGUST, 1866, *and of the same month for* SEVENTEEN *years, at Philadelphia, Pa.* Barometer 60 feet above mean tide in the Delaware River. Latitude 39° 57½′ N.; Longitude 75° 11¼′ W. from Greenwich. By PROFESSOR J. A. KIRKPATRICK, of the Central High School.

	August, 1867.	August, 1866.	August, for 17 years.
Thermometer—Highest—degree	86·00°	88·06°	97·00°
" date	14th.	1st & 2d.	2, '56; 4, '59.
Warmest day—mean	80·67	81·50	88·50
" " date	19th.	2d.	10th, '63.
Lowest—degree	59·00	57·00	47·00
" date	1st.	24th.	26th, '56.
Coldest day—mean	67·50	62·00	59·00
" " date	31st.	23d.	26th, '56.
Mean daily oscillation	12·44	14·03	15·24
" " range	3·68	3·77	3·69
Means at 7 A. M.	71·02	67·82	70·85
" 2 P. M.	78·18	78·36	81·01
" 9 P. M.	74·56	71·32	73·93
" for the month	74·59	72·50	75·26
Barometer—Highest—inches	30·210	29·957	30·255
" date	31st.	17th.	20th, '55.
Greatest mean daily pressure	30·128	29·935	30·229
" " " date	26th.	12th.	20 & 31, '55.
Lowest—inches	29·578	29·376	29·356
" date	16th.	9th.	20th, '56.
Least mean daily pressure	29·599	29·459	29·388
" " " date	16th.	9th.	20th, '56.
Mean daily range	0·108	0·096	0·095
Means at 7 A. M	29·967	29·750	29·865
" 2 P. M	29·939	29·711	29·836
" 9 P. M	29·944	29·751	29·856
" for the month	29·950	29·737	29·852
Force of Vapor—Greatest—inches	0·815	0·818	1·024
" date	14th.	9th.	1st, '54.
Least—inches	·317	·351	·268
" date	30th.	17th.	Often.
Means at 7 A. M.	·602	·522	·584
" 2 P. M	·609	·547	·592
" 9 P. M.	·645	·568	·613
" for the month	·619	·546	·596
Relative Humidity—Greatest—per cent	92·0	95·0	100·0
" date	15th & 22d.	13th & 14th.	26th, '54.
Least—per cent.	36·0	42·0	27·0
" date	11th & 26th.	18th.	1st, '60.
Means at 7 A. M.	78·7	75·4	76·2
" 2 P. M.	63·4	56·7	56·4
" 9 P. M.	75·2	73·7	73·1
" for the month	72·4	68·6	68·6
Clouds—Number of clear days*	9·	10·	9;5
" cloudy days	22·	21·	21·5
Means of sky covered at 7 A. M	63·2 per ct	52·9 per ct	56·3 per ct
" " " 2 P. M	63·5	59·7	61·3
" " " 9 P. M	44·5	36·1	41·7
" " for the month	57·1	49·6	53·1
Rain—Amount—inches	16·840	2·567	4·520
No. of days on which rain fell	15·	12·	10·1
Prevailing Winds—Times in 1000	s52° 26′ E ·094	s86°56′ w·336	s67°16′ w·081

* Sky one-third or less covered at the hours of observation.